of stainless steel with a hollow core through which a conductor (not shown) extends for providing connection to an electrical circuit. When the circuit is energized, the stainless steel heater **265**, being of relatively high resistance material, develops heat at the very end for softening the gutta percha material with which it is used.

When used in the practice of my method in filling a root canal with gutta percha material in a single compression wave, existing heat carrier/pluggers have a tendency to bend in the mid portion. I provide a thin stainless steel support member **268** which is welded or soldered to the tool **260** along the back thereof between the points A and B, along line **270**. The shape of the support member **268** in the region between points B and C conforms closely to the shape of the nose of the chuck **264** of the handpiece **262** but is not affixed thereto. This permits the chuck **264** to be rotated during tightening and loosening of the shank of the tool **260** while limiting the extent that the tool can give during use, since the slightest bend brings the adjacent surface of the support member **268C** into contact with the nose of the chuck **264** and prevents any further bending.

FIG. **18B** shows two versions of the heat carrier/plugger tool **260** of FIG. **18A** associated with respectively corresponding gutta percha cones. In the pair designated A, the gutta percha cone has the traditional taper of presently used gutta percha cones. The heat carrier/plugger **260A** is provided with a taper which corresponds to these traditional tapers, thereby enabling the tool to be inserted into or near the apical region of the root in a single wave of condensation. In the pair designated B in FIG. **18B**, the gutta percha point is like the point **230** in view E of FIG. **17** with a taper beginning at point **232** and extending to the fine tip **234**. The tapered portion **266** of the heat carrier/plugger **260B** begins at a point **267** and corresponds to the tapered portion of the gutta percha point **230**. Use of the heat carrier/plugger **260** in the canal filling method of my invention is represented schematically in FIG. **19**.

In FIG. **19**, the heat carrier/plugger **260** is tapered to correspond to the shape of the canal which has been formed prior to the filling step. The taper may correspond to that of tool **260A** for use with conventional tapered gutta percha cones prepared by using other shaping files or it may have the taper of the terminal portion **266** of the tool **260B**, corresponding to the taper in the terminal portion of the gutta percha point **230** (see FIG. **18B**). As indicated in FIG. **19**, view A, the gutta percha point is fully inserted into the root canal. The distal end of the heat carrier/plugger **260** is inserted into the canal cervical region and energized to soften and permit the heated tip element **265** to move through the gutta percha material within the canal. As the tool **260** moves further into the root canal, it develops hydraulic pressure which forces the softened gutta percha material and sealer cement into the lateral branch portions of the canal, represented at **274**. Finally, as shown in view C, the heat carrier/plugger **260** is withdrawn, leaving the lateral branches **274** and the apical portion of the root canal filled and sealed with the obturation materials.

FIG. **20** (views A through D) shows a tapered heat carrier/plugging tool **300** as it is used to soften and downpack through a pre-fit gutta percha cone **246** in a continuous wave of condensation. FIG. **20A** shows the electric heat carrier/plugger **302** withdrawn into its condensation sheath **304** in preparation for heating and compacting gutta percha into the canal. FIG. **20B** shows the first move into the canal with the heat carrier on high heat level, with the tool searing into the gutta percha cone until the compaction sheath binds the canal near its orifice level, thus creating the secondary seal necessary for a closed system within which to exert optimally controlled hydraulic compaction forces on the heat-softened gutta percha and the less viscous sealer against the canal walls. FIG. **20C** shows the second move into the canal as the heat carrier/plugger **302** is extended out of the compaction sheath **304**, heating and plastically deforming the gutta percha and sealer into all dimensions of the root canal system. FIG. **20D** shows the withdrawal of the tool **300** from the canal after the extended heat carrier/plugger **302** bottoms out near the apical terminus of the canal, with the soft sticky surplus gutta percha and sealer removed from the canal on the tool. The canal is shown ready for restorative post placement of the type specified in FIG. **17**, or for backfilling with the tool and material shown in FIG. **21**.

FIG. **21** shows another electric heat carrier of a configuration to afford fast ideal backfilling of canals which have been downpacked but not posted. FIG. **21A** shows a preformed gutta percha plug **230** with the shape of the empty coronal part of the canal and a groove or hole **231** to allow introduction of the narrow electric heat carrier of FIG. **21B**. FIG. **21B** shows a tool **320** whereby a narrow, parallel heat carrier **322** extends through the end of a hollow or notched plugger **324**. FIG. **21C** shows a gutta percha plug **230** mounted on the backfilling tool **320**, and that set of tool and materials placed in the empty coronal part of the canal with sealer **326**. FIG. **21D** shows that same tool/material set after heat has been created by the heat carrier **322**, softening the end of the gutta percha plug **230**. As the heat carrier tip **322** is withdrawn coronally, the plugger **324** is pushed apically, thereby condensing the gutta percha **230** from its tip to its butt end. FIG. **21E** shows the termination of backfilling as the heat carrier tip **322** is fully retracted into the plugger **324**, resulting in a dense obturation of the softened gutta percha.

Although there have been described hereinabove various specific arrangements of an endodontic treatment system in accordance with the invention for the purpose of illustrating the manner in which the invention may be used to advantage, it will be appreciated that the invention is not limited thereto. Accordingly, any and all modifications, variations or equivalent arrangements which may occur to those skilled in the art should be considered to be within the scope of the invention as defined in the annexed claims.

What is claimed is:

1. A set of endodontic files for use in preparing root canals in teeth wherein the files vary in taper, one from another, each file comprising:

a shank;

a tip; and

a flute portion which extends between the tip and the shank;

wherein each of said files having a greater taper than another one of the files in said set has a shorter flute portion than said other file.

2. The set of files of claim **1** wherein the shank of each file has a proximal end, remote from said flute portion, which is embedded in a pear-shaped handle comprising a scored tapered section having an enhanced gripping area to facilitate applying torque to the file in combination with apically directed force.

3. The set of files of claim **1** wherein the shanks of said files in the set are all of the same diameter.

4. The set of files of claim **1** wherein in each file the diameter of the largest flute in said flute portion is greater than the shank diameter and wherein the file includes a transition portion extending from the largest diameter flute to the shank, said transition portion including a pair of lands diminishing in diameter from the largest diameter flute to the shank.

5. The set of files of claim 4 wherein said shank has a diameter equal to approximately 95% of the diameter of the largest flute.

6. The set of files of claim 4 further including a shank guide which is spaced along the shank from the largest diameter flute by a distance which allows a chip space for tooth dust to collect during filing procedures.

7. The set of files of claim 1 wherein the tip of each file is smoothly rounded and devoid of cutting edges.

8. The set of files of claim 7 wherein the tip has a diameter which is slightly smaller than the diameter of the smallest diameter flute.

9. The set of files of claim 8 further including a second transition section between the tip and the flute portion which includes a pair of lands continuing from the smallest diameter flute to the tip.

10. The set of files of claim 1 wherein the flute portion of each file includes a plurality of flutes, each provided with cutting edges about the periphery of the file, said cutting edges diminishing in diameter and increasing in pitch and sharpness with distance from the largest diameter flute.

11. The set of files of claim 1 wherein each file of said set comprises a Hedstrom-type file with the cutting edges dulled along one side of the file and wherein the lengths of the flute portions vary inversely with the degree of file taper.

12. The set of files of claim 1 wherein each file of said set comprises a K-type file with the cutting edges dulled along one side of the file and wherein the lengths of the flute portions vary inversely with the degree of file taper.

13. The set of files of claim 1 wherein each file of said set comprises a Hedstrom-type file with the cutting edges dulled along one side of the file and wherein the lengths of the flute portions vary inversely with the diameter of the file tip.

14. The set of files of claim 1 wherein each file of said set has a preselected curve in a region of the flute portion near the tip which is set in the file during fabrication.

15. The set of files of claim 14 wherein each file of said set is fabricated of a nickel-titanium alloy.

16. The set of files of claim 15 wherein said alloy is Nitinol™.

17. A set of endodontic files for use in preparing root canals in teeth wherein the files vary in taper, one from another, each file comprising:

a shank varying in diameter from every other file in said set;

a tip varying in diameter from every other file in said set; and

a flute portion which extends between the tip and the shank, the flute portions of all files in said set being the same length;

wherein each of said files having a greater taper than another one of the files in said set has a larger diameter tip and a larger diameter shank than said other file.

18. The set of files of claim 17 wherein the taper varies from 0.01 mm/mm for the smallest diameter file to 0.05 mm/mm for the largest diameter file in said set.

19. The set of files of claim 18 wherein the variation in taper from file to file is 0.01 mm/mm.

20. The set of files of claim 17 wherein the variation in shank diameter from file to file is 0.185 mm.

21. The set of files of claim 17 wherein the length of the flute portion of each file of said set is 16 mm.

22. The set of files of files of claim 17 wherein the variation in tip diameter from file to file is 0.025 mm.

23. The set of files of claim 17 wherein a first file of said set has a tip diameter of 0.075 mm, a shank diameter of 0.235 mm, and a taper of 0.01 mm/mm.

24. The set of files of claim 17 wherein a second file of said set has a tip diameter of 0.1 mm and a shank diameter of 0.420 mm, and a taper of 0.02 mm/mm.

25. The set of files of claim 17 wherein a third file of said set has a tip diameter of 0.125 mm, a shank diameter of 0.605 mm, and a taper of 0.03 mm/mm.

26. The set of files of claim 17 wherein a fourth file of said set has a tip diameter of 0.15 mm, a shank diameter of 0.790 mm, and a taper of 0.04 mm/mm.

27. The set of files of claim 17 wherein a fifth file of said set has a tip diameter of 0.175 mm, a shank diameter of 0.975 mm, and a taper of 0.05 mm/mm.

28. The set of files of claim 17 wherein the shank of each file has a proximal end, remote from said flute portion, which is embedded in a handle configured to facilitate manipulation of the associated file.

29. The set of files of claim 28 wherein each file handle is pear-shaped and configured to provide an enhanced gripping area to facilitate the application of torque to the file in combination with apically directed force.

30. The set of files of claim 29 wherein the handle of each file is shaped with planar proximal and distal ends oriented transversely to the longitudinal axis of the file.

31. The set of files of claim 30 wherein the handle of each file comprises a smooth curved surface portion extending from the distal end to a maximum diameter and a scored section tapering from the plane of maximum diameter to said proximal end of said handle.

32. The set of files of claim 31 wherein the scored section of each file handle comprises 70% to 85% of the length of the handle.

33. The set of files of claim 32 wherein the scored section of each handle is 80% of the length of the handle.

34. The set of files of claim 33 wherein the handle of each file is 10 mm in overall length and the length of the scored section is 8 mm.

35. The set of files of claim 31 wherein the scored section of each file handle comprises a plurality of longitudinally directed grooves oriented side-by-side about the periphery of the handle, each of said grooves tapering slightly in width from the plane of maximum diameter to the proximal end of the handle.

36. The set of files of claim 35 wherein each of said grooves comprises a pair of beveled sides intersecting at the bottom of the groove.

* * * * *

37. An endodontic file having the capability of developing a predefined shape throughout the full length of the root canal of a tooth, said file having dimensions of diameter and length of its cutting portion matching a particular tooth root canal; said file comprising:

a shank;

a tip remote from said shank and having a diameter corresponding to the diameter of the terminus of said predefined shape of said root canal;

a flute portion extending between said shank and said tip and having a taper which is greater than the standard ISO file taper, said flute portion having at least one spiral cutting edge throughout its length;

said shank having a diameter determined by the diameter of the tip, the taper of the flute portion, and the length of the flute portion.

38. The file of claim 37 wherein said flute portion having said at least one spiral cutting edge varies in pitch along its length.

39. The file of claim 38 wherein the ratio of flute pitch adjacent the shank to flute pitch at the tip is four.

40. The file of claim 38 wherein the ratio of flute pitch at any point along the flute portion to flute pitch at the tip diminishes linearly with distance from the shank along the

flute portion.

41. The file of claim 37 wherein said flute portion having said at least one spiral cutting edge varies in relative sharpness along its length.

42. The file of claim 41 wherein said at least one spiral cutting edge is sharpest at the end next to said shank and dullest in the vicinity of the file tip.

43. The file of claim 37 wherein said flute portion comprises a plurality of angled flutes throughout its length.

44. The file of claim 43 wherein the angle of the individual flutes relative to the axis of the shank varies along the length of the flute portion.

45. The file of claim 44 wherein the angle of the flutes adjacent the shank is less than the angle of the flutes in the vicinity of the tip.

46. The file of claim 37 wherein at least a portion of the material of the file is a nickel-titanium alloy.

47. The file of claim 46 wherein the region of the flute portion in the vicinity of the tip is made of nickel-titanium alloy.

48. The file of claim 47 wherein said file is treated to establish a permanent curvature in said nickel-titanium portion adjacent the tip to enable the file to penetrate curved apical regions of the root canal more readily.

49. The file of claim 43 wherein the shank has a slightly smaller diameter than the diameter of the flute nearest the shank in order to avoid binding of the file shank in a root canal.

50. The file of claim 49 wherein the diameter of the shank is about 5% less than the diameter of the flute adjacent the shank.

51. The file of claim 49 further including a pair of transitional lands extending from the flute adjacent the shank to the shank itself in order to better guide the file in the root canal.

52. The file of claim 37 wherein said flute portion is provided with three spiral cutting edges throughout its length which define bridging surfaces between adjacent cutting edges, said cutting edges being equally displaced about the periphery of the flute portion and each bridging surface between adjacent cutting edges having a general S-shape when viewed in cross section.

53. The file of claim 37 wherein said flute portion is provided with three spiral cutting edges throughout its length, the

cross section of said flute portion being in the shape of an equilateral triangle.

54. The file of claim 37 wherein said flute portion is provided with six spiral cutting edges throughout its length, the cross section of said flute portion being hexagonal.

55. The file of claim 37 wherein the flute portion has three spiral cutting edges throughout its length equally displaced about the circumference of the flute portion which define bridging surfaces between adjacent cutting edges, wherein the bridging surfaces between adjacent cutting edges are concave.

56. The file of claim 37 wherein the file tip is smooth and devoid of cutting edges.

57. The file of claim 38 wherein said flute portion having said at least one spiral cutting edge varying in pitch along its length also varies in relative sharpness along its length.

58. The file of claim 41 wherein said flute portion having at least one spiral cutting edge varying in relative sharpness along its length also varies in pitch along its length.

59. The file of claim 37 wherein said shank is fitted for driving in a handpiece.

60. An endodontic file for use in preparing a root canal

in a tooth, said file having a shank, a working portion and a tip, said file having a predetermined shape for forming a substantially tapered root canal from crown to apex of said root canal, said file comprising:

a file shank fitted for driving in a handpiece;

said file working portion being formed of nickel titanium alloy;

said file working portion taper being greater than ISO Standard of 0.02 mm/mm of axial length; and

said file working portion having at least one helical cutting flute containing an edge which is shaped to provide a predetermined cross-sectional profile.

61. The file of claim 60 wherein said predetermined cross-sectional profile is linear.

62. The file of claim 60 wherein said predetermined cross-sectional profile is S-shaped.

63. The file of claim 60 wherein said at least one helical cutting flute varies in pitch along its length.

64. The file of the claim 63 wherein the ratio of flute pitch at any point along the flute portion to flute pitch at the tip diminishes linearly with distance from the shank along the flute portion.

65. The file of claim 60 wherein the edge of said at

least one helical cutting flute varies in sharpness along the file working portion.

66. The file of claim 65 wherein the degree of sharpness of said edge diminishes with distance from said shank along said working portion.

67. An endodontic file comprising:

a shank having a latch-grip for attachment to a dental handpiece;

a file working portion formed of nickel titanium alloy and having a taper greater than 0.02 mm/mm of axial length; and

said working portion having at least one helical cutting flute forming a cutting edge having a predetermined cross-sectional profile.

68. The file of claim 58 wherein said predetermined cross-sectional profile is linear.

69. The file of claim 58 wherein said predetermined cross-sectional profile is S-shaped.

70. The set of files of claim 1 wherein the flute portion of each file includes a plurality of flutes, each provided with cutting edges about the periphery of the file, said cutting edges diminishing in diameter and sharpness and increasing in pitch with distance from the largest diameter flute.